POLISH POLAR RESEARCH	9	4	461—474	1988

Jerzy NITYCHORUK and Jan DZIERŻEK

Institute of Geology
Warsaw University
Żwirki i Wigury 93
02-089 Warszawa, POLAND

Annual mass movements in northwestern Wedel Jarlsberg Land, Spitsbergen

ABSTRACT: Methods and results of mass movement measurements on mountain slopes in northwestern Wedel Jarlsberg Land are presented in connection with morphoclimatic zones. Debris movement was investigated using fishing nets while movement of solifluction tonques was studied with series of nails. Marks and lines crosswise the investigated forms were also painted. Creeping of stone belts was measured with a use of tree-nails. Observations of these measuring points after twelve months show usability of employed methods for a record of mass movements.

Key words: Arctic, Spitsbergen, mass movements

Introduction

Research was carried through in northwestern Wedel Jarlsberg Land in 1986 during the expedition organized by the Maria Curie-Skłodowska University of Lublin. Three morphoclimatic zones were distinguished on the basis of the present slope processes (Nitychoruk and Dzierżek 1988).

Zone A (below the 150 m a.s.l.) is beyond a direct glacier influence on slope processes (Fig. 1). Occurrence of full grown talus cones with straight and concave profiles, and often with nival moraines at their lower ends, are the characteristic features of this zone. Surfaces of debris covers are often modelled by solifluction. Zone B (150—350 m a.s.l.) is influenced (in its microclimate and mechanically) by glacier snouts. Talus cones are the most common there. They are composed of loose, unweathered and nonselected debris. Fresh furrows of mud-debris flows occur on cone surfaces. Zone C (over the 350 m a.s.l.) is influenced by firn fields while slope processes are limited there.

At the beginning of summer 1986 several observation points were fixed

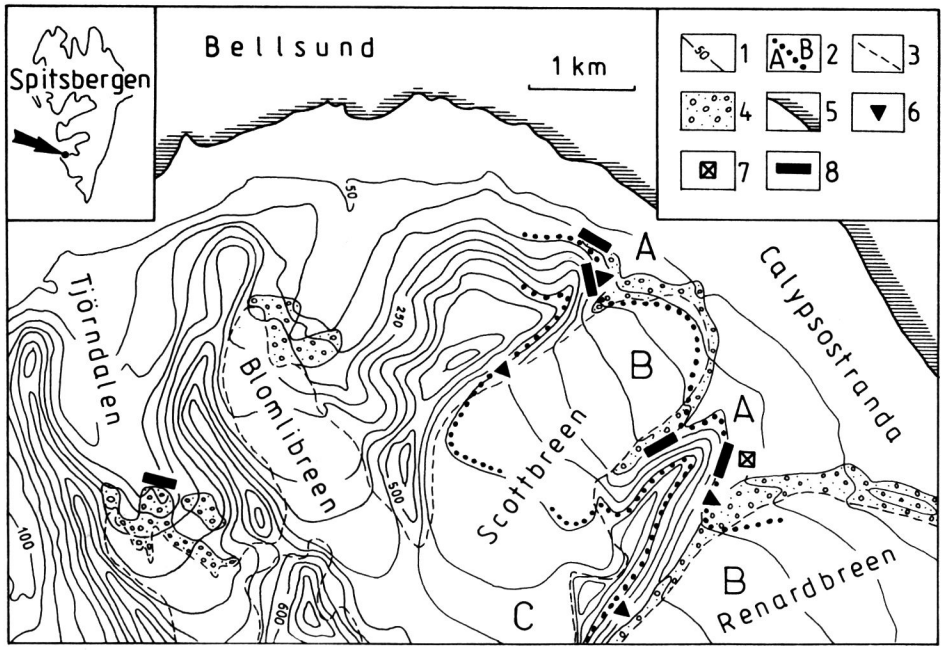


Fig. 1. Location of observation sites in northwestern Wedel Jarlsberg Land
1 — contour lines, 2 — borders of morphoclimatic zones (after Nitychoruk and Dzierżek 1988): A — zone beyond direct influence of glaciers, B — zone under influence of glacier snouts, C — zone under influence of firn fields, 3 — glacier limit, 4 — ice-cored moraines, 5 — coastline, 6 — location of net on talus cones, 7 — test field for development of polygons, 8 — nail series, marks and lines for measurements of movement of solifluction tongues and rock glaciers

by the authors in order to obtain dynamics of slope processes in individual zones (Fig. 1). Verification after 2 months indicated no changes (Dzierżek and Nitychoruk 1987b). Repeated measurements were carried out by Dr. T. Merta and Dr. W. Ozimkowski in 1987 during the next expedition to Spitsbergen. Small changes at all observation points were noted. Presented methods of mass movement measurements were already used in Spitsbergen by Rapp (1960), Jahn (1961, 1970), Czeppe (1966), Pękala (1980) and in the Polish Tatra Mts. by Kotarba (1976, 1987) and Rączkowski (1981).

Methods and results

Ratio of talus cones growing was possible due to a use of fishing nets located at lower parts of 4 talus cones. Studied areas were different and equal 18, 20, 25 and 42 m^2 respectively (Fig. 1, Pl. 1), because only such fragments of fishing nets were found on a beach. Debris deposition

rate in different zones was made with nets (*cf.* Kotarba 1987) installed in the zones A and B on cones of similar sizes, inclination and exposure. On a net in the zone A by the Renardbreen eight rock pieces with diameters to 7—10 cm and volume of 2 dm^3 have been deposited during a year (Pl. 1). On a net by the Scottbreen only five rock fragments with diameters to 5—20 cm and volume of 3 dm^3 were found (Pl. 2, Fig. 1).

In the zone B by the Renardbreen large accumulations of rock debris of approximate volume about 20 dm^3 were noted. They seem to represent a rock avalanche (Fig. 2; Pl. 2, Fig. 2). Talus cones in the zone B close to the Renardbreen and Scottbreen are composed of different material. Unfortunatelly the net installed in the previous year by the Scottbreen has not been found what makes comparison of deposition ratios on talus cones composed of different material impossible. Transport of talus debris was investigated with a use of lines painted crosswise the cones and ended at mark points on rock walls. After a year no significant changes were however observed.

Upper parts of talus cones which are mainly composed of fine debris, get usually transformed by solifluction. Solifluction tonques move with a speed dependent on exposure (*cf.* Kotarba 1976). The speed was evaluated with a use of nails knocked into tonque surfaces (Pl. 3) at altitudes from 150 to 180 m a.s.l. (Fig. 1). Changing distances between nails and mark line installed above were compared. After a year the maximum change by solifluction of 5 cm was noted on the talus cone exposed to the northwest

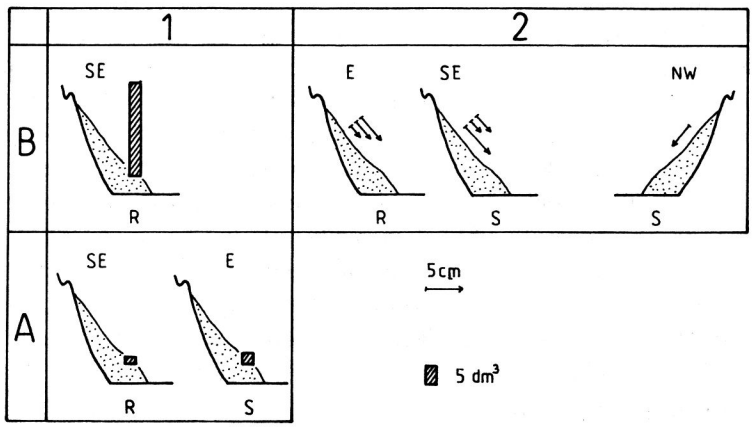


Fig. 2. Selected results of measurements of annual development of mass movement in northwestern Wedel Jarlsberg Land

1 — estimated volume of debris deposited on nets, 2 — downslope movement of solifluction tonques; A — zone beyond direct influence of glaciers, B — zone under influence of glacier snouts, R — surroundings of the Renardbreen, S — surroundings of the Scottbreen; SE, E, NW — expositions of talus cones

near the Scottbreen (Fig. 2). One of nails was cut probably by a rock block (Pl. 4).

Movements of stone belts were observed with a use of two series of small nails. The series were composed of 38 and 17 nails respectively, knocked at regular intervals and compared with mark points on solid rocks. The belts were arranged perpendicularly to structural axes of slopes with gradients of about 10° (Pl. 5) and 5° (Pl. 6). After a year only very small changes (to 1 cm) were noted and therefore, the observation period seems to be too short for any remarkable changes to develop on gentle slopes.

Movement of a moraine rock glacier in Tjörndalen (Fig. 1; Pl. 7, Fig. 1; *cf.* Dzierżek and Nitychoruk 1987a) was studied with a use of 5 nails knocked at the feature foot. Distances between nails and characteristic points at glacier slope were measured (Pl. 7, Fig. 2). After a year a nail inclination at the glacier margin has changed (Pl. 8).

The attempt of separation of stable nival moraines from presumed moving rock glaciers failed as the marked blocks on their margins have not changed their location during a year.

Final remarks

Presented preliminary results of mass movement observations in different morphoclimatic zones in northwestern Wedel Jarlsberg Land initiated a series of observations. At present the collected material is incomplete and does not allow for detailed estimation of rate of slope processes in described area. However usefulness of applied methods was demonstrated. Results of such measurements cannot be used for quantitative characteristics of slope phenomena (*cf.* Jahn 1961, Rapp 1960, Kotarba 1976). Obtained rates are of individual value for every place whereas mean values do not represent the activity of areal processes. Measurements of mass movements are used by the authors to define the genesis of relief-forming processes and their influence on development of the present landscape, in connection with all natural conditions of a studied place. Such knowledge enables a more complete analysis of relief development in the mountains which have been glaciated during the Pleistocene. However twelve-month observation period is not reliable. Talus cones in Spitsbergen have been developing for several thousand years and with varying intensity. Data contained in this paper (Fig. 2) do not describe the growing rate of studied forms. They only indicate their possible permanent development. In order to eliminate the accidental errors caused by single measurements the observations should by continued.

Conclusions

1. Evaluation of rates of mass movements should be very careful due to complicated character of described processes and short observation period.

2. Differences in growing of talus cones depend on their altitude, exposure and location against different parts of glaciers. The most intensive deposition is noted for the zone B, influenced by glacier snouts. It results from intensive weathering, especially on slopes with a southeastern exposure.

3. Development of solifluction depends on exposure and slope inclination. Maximum rate was equal 5 cm a year and observed on a southeastern slope with inclination equal 25°. Flow of debris on a slope with 10° inclination was insignificant (maximum 1 cm a year).

4. Movement of a rock glacier after a year was imperceptible.

5. Morphoclimatic zones distinguished previously (Nitychoruk and Dzierżek 1988) are reflected in varying rates of mass movements.

Acknowledgements. — Authors are much indebted to Dr. T. Merta and Dr. W. Ozimkowski (both from the Institute of Geology, Warsaw University) for verificating measurements and photographic documentation.

References

André M. F. 1986. Dating slope deposits and estimating rates of rock wall retreat in northwest Spitsbergen by lichenometry. — Geogr. Ann., 68 A: 65—76.

Czeppe Z. 1966. The course of the main morphogenetic processes in south-west Spitsbergen. — Zesz. Nauk. Uniw. Jagiell., Pr. Geogr., 13: 129 pp.

Dzierżek J. and Nitychoruk J. 1987a. Types of rock glaciers in northwestern Wedel Jarlsberg Land, Spitsbergen. — Pol. Polar Res, 8: 231—241.

Dzierżek J. and Nitychoruk J. 1987b. Stożki usypiskowe okolic Bellsundu, Spitsbergen. — 14 Symp. Polarne, Lublin, Mat.: 92—94.

Jahn A. 1961. Quantitative analysis of some periglacial processes in Spitsbergen. — Zesz. Nauk. Uniw. Wrocł., Nauka o Ziemi, 5: 1—27.

Jahn A. 1970. Zagadnienia strefy peryglacjalnej. — Państw. Wyd. Nauk., Warszawa, 201 pp.

Kotarba A. 1976. The role of morpfogenetic processes in modelling high-mountain slopes. — Pr. Geogr. Inst. Geogr. Pol. Akad. Nauk, 120: 128 pp.

Kotarba A. 1987. High-mountain denudational system of the Polish Tatra Mts. — Geogr. Stud. Inst. Geogr. Spat. Org., Pol. Ac. Sc., 3: 106 pp.

Nitychoruk J. and Dzierżek J. 1988. Morphogenetic features of debris cones in northwestern Wedel Jarlsberg Land, Spitsbergen. — Pol. Polar Res., 9: 73—85.

Pękala K. 1980. Morphogenetic processes and deposits of nunataks in the Hornsund area, SW Spitsbergen. — Pol. Polar Res., 1: 9—44.

Rapp A. 1960. Talus slopes and mountain walls at Tempelfjorden, Spitsbergen. — Norsk Polarinst. Skr., 119: 96 pp.

Rączkowski W. 1981. Differentiation of present-day gravitational processes in Dolina Pięciu Stawów Polskich, the High Tatra Mts, Poland. — Biul. Inst. Geol., 332: 139—151.

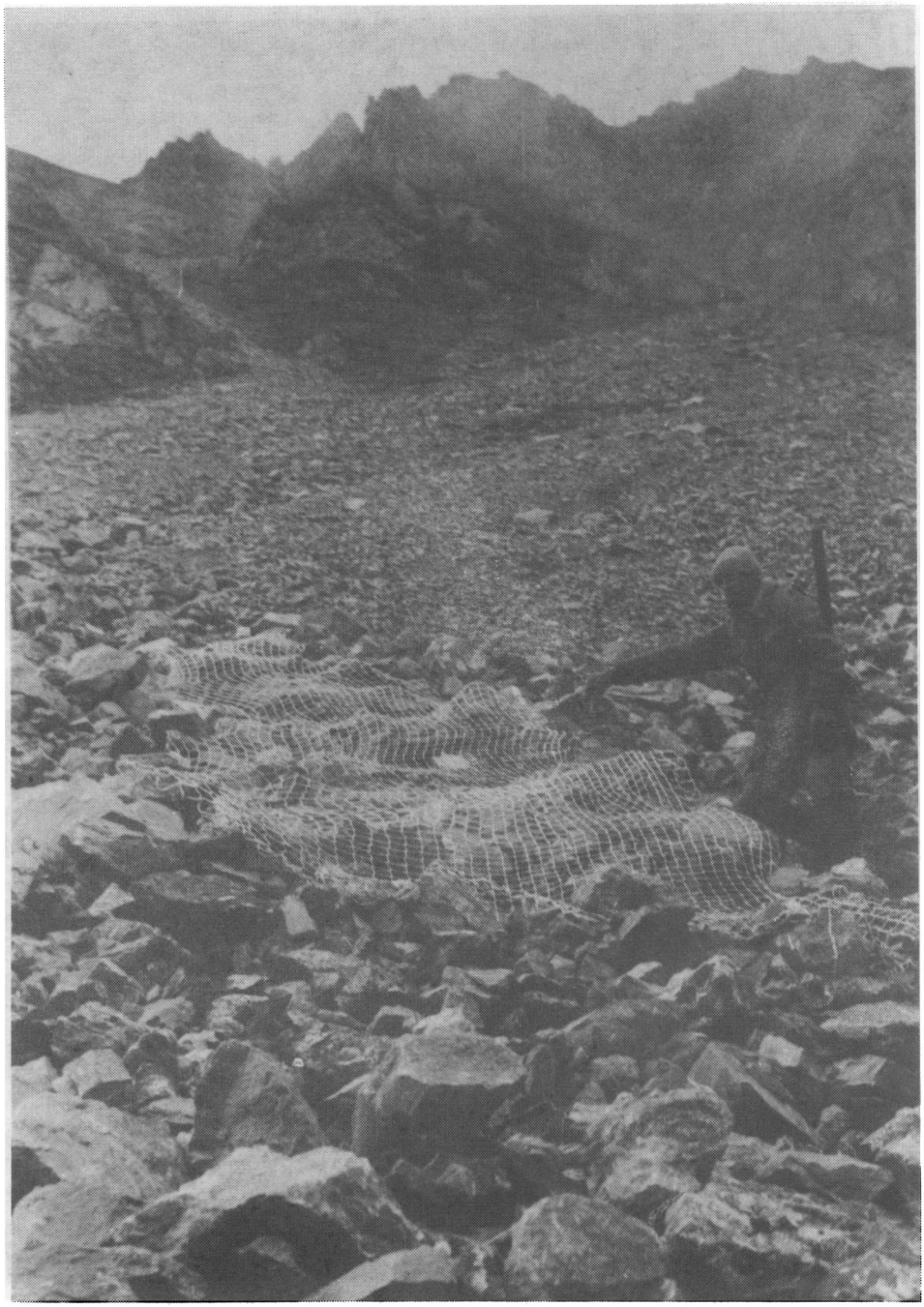
Received April 19, 1988
Revised and accepted June 29, 1988

Streszczenie

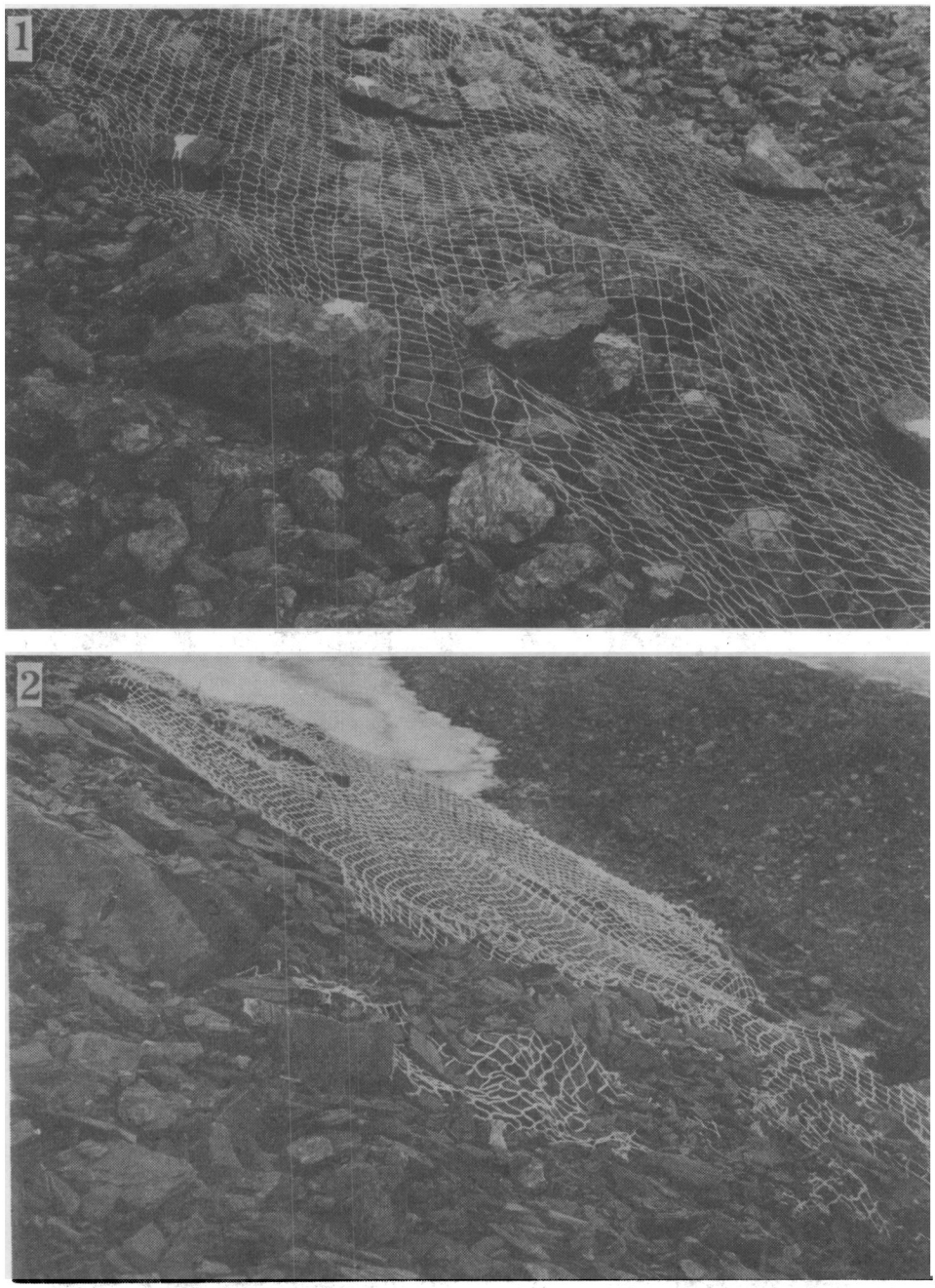
Przedstawiono metody i wyniki pomiarów jednorocznego rozwoju ruchów masowych na zboczach górskich w NW części Ziemi Wedela Jarlsberga w nawiązaniu do wcześniej wydzielonych stref morfoklimatycznych (fig. 1). Do określenia ruchu gruzu na powierzchniach stożków usypiskowych użyto siatek rybackich (pl. 1, 2). Do określenia ruchu jęzorów soliflukcyjnych na stoku (pl. 3, 4) i lodowców gruzowych (pl. 7, 8) zastosowano szeregi kołków drewnianych wbitych w powierzchnię formy i w najbliższe jej otoczenie oraz znaki i linie malowane farbą w poprzek form. W celu stwierdzenia tempa rozwoju gruntów strukturalnych na powierzchniach o małym nachyleniu posłużono się szeregiem regularnie wbitych kołeczków (pl. 5, 6). Obserwacja takich punktów pomiarowych po roku ich funkcjonowania wykazała niewielkie zmiany.

Różna ilość gruzu znaleziona na siatkach (fig. 2) potwierdziła przypuszczenie o najszybszym rozwoju zjawisk zboczowych w strefie kontaktu zbocza z jęzorem lodowcowym (*por.* Nitychoruk and Dzierżek 1988). Zmiana położenia niektórych kołków wskazuje na jednoroczny rozwój niektórych form (jęzory soliflukcyjne, pasy kamieniste). Zwrócono uwagę na niedoskonałości zastosowanych metod oraz zbyt krótki okres obserwacji, które ograniczają wykorzystanie otrzymanych wyników do wyciągania szerszych wniosków.

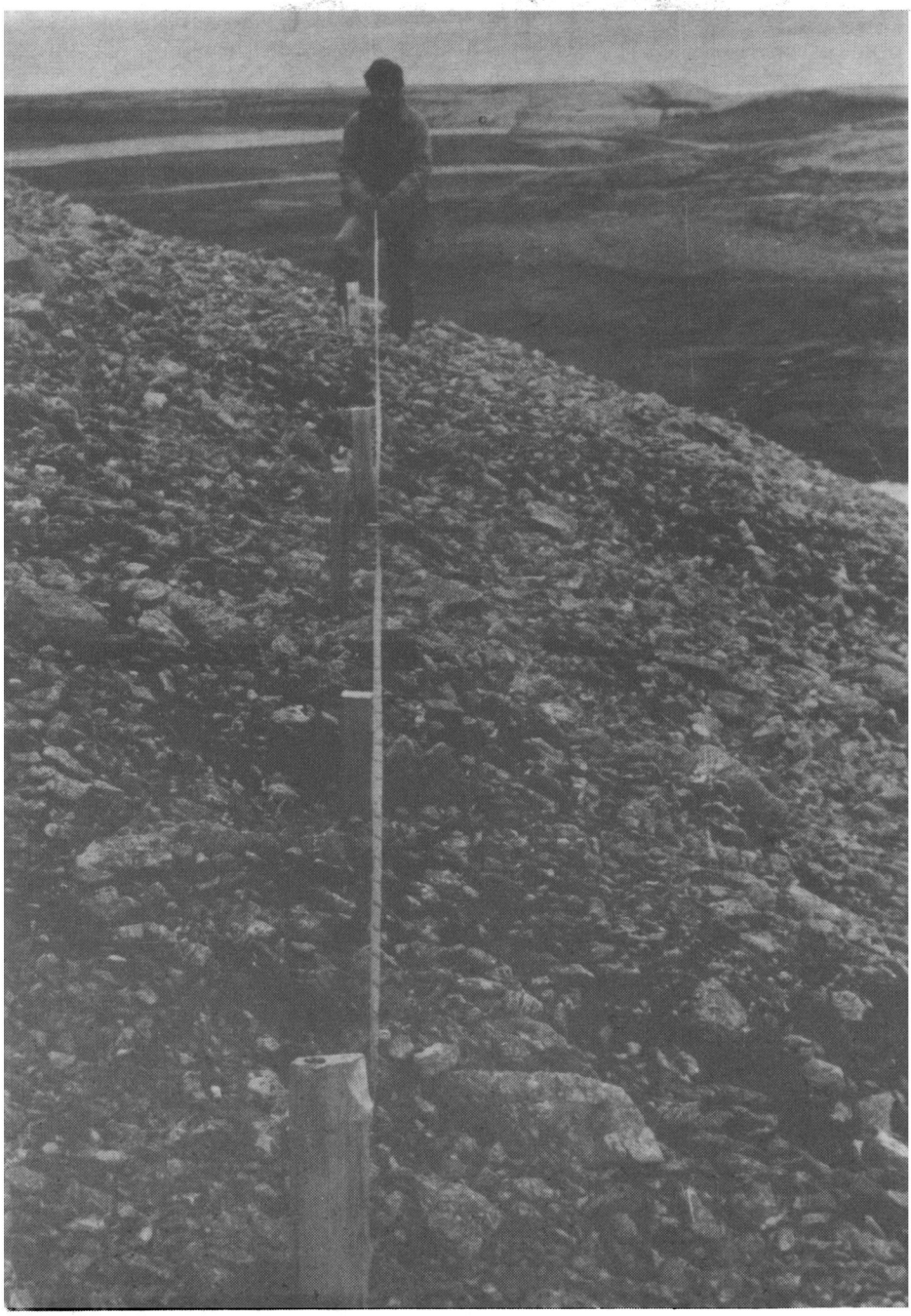
Opracowanie wykonano w ramach CPBP 03.03. B.7.



Fishing net for measurements of debris movement on talus cones; zone A, near the Renardbreen

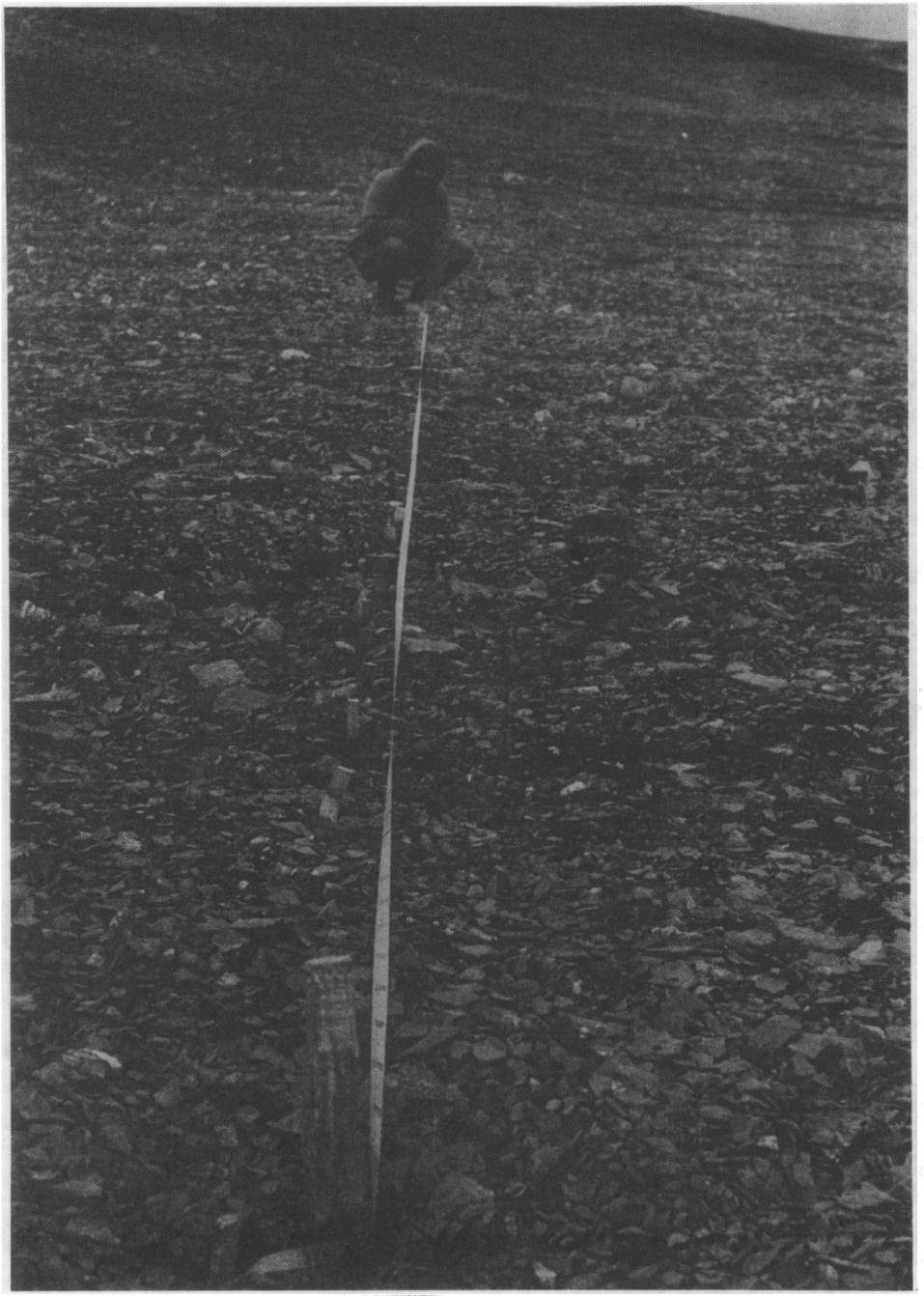


1. Few fragments of rock debris preserved on a net in the zone A after a year; near the Scottbreen
2. Rocky material (stony avalanche) on a net in the zone B near the Renardbreen

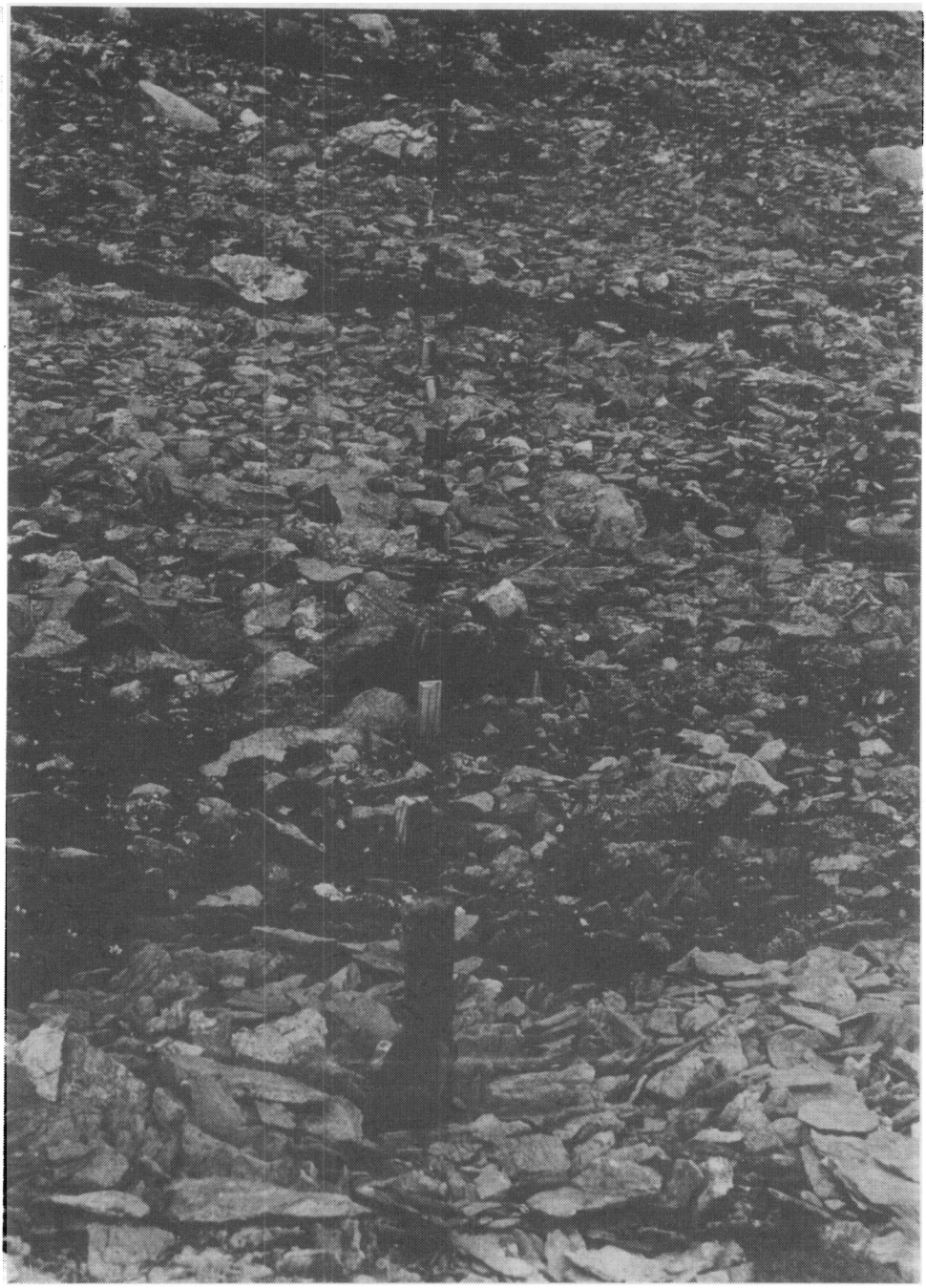


Inclined nails indicating a moving solifluction tonque near the Renardbreen

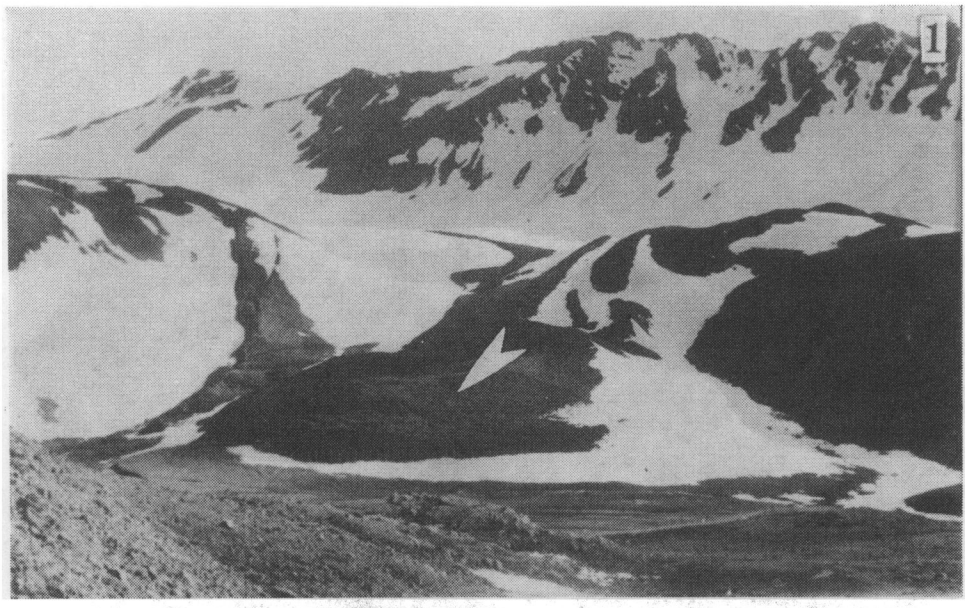
Nail cut by a block near the Scottbreen



Nails knocked in stone belts developed on a slope with inclination of 10° near the Renardbreen



Nails knocked in stone belts developed on a slope with inclination of 5 near the Renardbreen



1. Front of a moraine rock glacier (arrowed) in Tjörndalen
2. Margin of a moraine rock glacier in Tjörndalen with nails installed for measurements of its movement

Inclined nail at the contact of a rock glacier and the floor of the Tjörndalen